1899

Formalin for Grain and Potatoes

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[Extract from Bulletin 77, March, 1899. Indiana Agricultural Experiment Station.]

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Among the most notable advances of recent years in the treatment of crops, none has a more direct bearing upon the success of the cultivator than the use of preventives for specific plant diseases. In horticulture and floriculture, where intensive methods are most practiced, spraying and fumigation, together with some other forms of application, have become the customary procedure with all careful growers. In agriculture the advance along this line has been by no means so great. In farm operations only relatively simple and inexpensive methods are likely to find much favor, owing to the large bulk of seed that must be treated or the large area of growing crops to be dealt with and especially as the operations must as a rule be given over to unskilled labor. But there is good reason for believing that many, if not all, of the more destructive diseases that vex the farmer, and scale down or obliterate his profits, will eventually be brought under the possible control of the thrifty husbandman.

Wheat, Oats and Corn.

Fifteen years ago at the New York experiment station, the first field count of smutted heads of oats was made, by which the conclusion was reached that on an average ten per cent. of a crop may be lost without materially affecting the general aspect of the field, or giving adequate evidence of the loss to any but a practised eye. The comparative inconspicuousness of the smutted part of the crop as casually viewed in the field is doubtless the reason why the heavy losses which farmers sustain from this cause in general excite so little comment and apprehension.

Many estimates of losses have been made since 1884 in a number of the northern States by counting all the affected and unaffected heads over certain parts of the field, and these have shown from 0 to 60 per cent. of injury for oat smut, with a probable average loss for the whole country, taking one season with another, of between 8 and 10 per cent. Other kinds of smut may be even more destructive at times, but none is so remarkably constant in invading all fields in all seasons, where not protected by treatment.

The grain smuts may be divided into three classes in regard to treatment:

First. The infection is by wind-blown spores, affecting only small areas of the plant here and there at the spots where the spores alight. In this case treating the seed does no good, as the fungus does not start with the seed. It is necessary on the contrary to protect the whole surface of the plant above ground. Corn smut is of this nature, and the remedy is to spray the field a number of times with Bordeaux mixture, which has been found effective, but is not considered practical; or to gather the smut balls from the field while the crop is growing or at any other time and burn them, so that the spores can not be scattered and continue the attack upon the same or subsequent crops. The latter method is feasible and advantageous, and if followed up, will do much to reduce and prevent corn smut.

Second. The infection comes only or chiefly from spores attached to and sown with the seed, and with the death point of both spores and seeds, for such fungicidal agents as have been tried, so nearly the same that a satisfactory remedy is not yet available. The loose (black) smut of wheat is of this character. Whatever kills the spores on the seed grain kills the grain itself more or less completely. By a nice adjustment of the hot water treatment the loose smut can be cleaned out but with a heavy sacrifice of the seed, which is an uncertain and unprofitable procedure, unless one desires to obtain a clean crop without regard to expense or trouble. It is hoped that formalin can in some manner be made to meet the conditions, but the experiments now under way are not sufficiently advanced to permit of an opinion. At present there is no satisfactory remedy or preventive to be recommended for this kind of smut.

Third. The infection is by way of the seed, as in the last case, but the death point for a number of fungicidal agents is much lower for the spores than for the seeds, and it is only necessary to treat seed grain in the proper manner to entirely kill the smut without injury to the seed, in fact often with distinct benefit to the seed, and thereby secure a maximum crop free from smut. Of this sort are the oat smuts, and the hard (stinking) smut of wheat. There are a number of efficient remedies for these smuts: The copper sulfate (blue stone) treatment has been practiced for more than a century;

the hot water treatment is excellent and has met with much deserved favor; potassium sulfide, corrosive sublimate, "ceres pulver," and other substances, have been found serviceable.

A fungicide, however, which outweighs all others in efficiency, and convenience of application, is formalin. This was first tested with some fulness, and recommended as a practical remedy for smut, by Professor H. L. Bolley* of the North Dakota station. Its action on seeds and spores has been studied in a subsidiary way by a number of investigators, both in and outside of the experiment stations, but a full account of the subject must be left for another time. In this place only enough of the original data will be given to somewhat substantiate the general claim for the practical character of the proposed treatment.

The method of treatment is very simple: Add one-half pound of formalin to thirty gallons of water and immerse the seed for two hours, or wet the seed thoroughly by sprinkling and let it stand in a covered pile for the same length of time. Then spread and dry it sufficiently to sow in the usual manner.

Formalin can be obtained of almost any druggist, or can be ordered through one. It is supplied to the trade under two names: formalin and formaldehyde, sometimes varying in price, but both being a solution of formaldehyde gas in water of the supposed strength of 40%, so that it is immaterial under which name the substance is bought. The strength of the solution varies some, and it deteriorates slowly with age, but at the present time the only course open to the farmer is to accept what the druggist furnishes, and assume that it has the full strength of 40%, or practically that. A pound of formalin is in volume a little less than one pint.

Formalin is retailed both from the bulk and in original sealed pound bottles, the latter being somewhat safer to use, as there has been less chance of deterioration, but is somewhat more expensive. The price is declining. It can now be had for one dollar a pound or less, even as low as fifty cents from some large dealers.

The substance is a pungent gas, dissolved in water, being somewhat like ammonia in this respect. It is very irritating to the eyes and nose, and under too long exposure may naturally cause injury. It also produces a smarting of spots where the skin is

*N. D. Bulletin No. 27, March 1897.

removed, but is not likely to do any harm aside from the unpleasant feeling. In short the substance is not poisonous to man or beast, administered externally or internally, under ordinary conditions and modes of handling. Within reasonable bounds it is a harmless and safe material to use. It can be put into any kind of a vessel, as it does not corrode. The solution which is left over after treatment of seed, can be thrown out anywhere without endangering animals or plants, and if a moderate amount of the treated seed should be accidentally eaten by cows, hens, or other occupants of the farm, no harm is likely to follow.

The action of this substance is somewhat slower than that of the more common fungicides. It can not, therefore, be applied quite so rapidly, but on the other hand the range for safe application is far wider. If the seed should stay in the solution much longer than two hours, little or no injury would result to the grain, while the very last spores of the fungus would be all the more certainly reached. This is especially true for oats, as the seeds and spores are both much protected by the hulls. Yet the period of two hours fixed upon is about right for satisfactory treatment with the strength mentioned.

If more than one lot is to be treated, the same solution can be used over a number of times, certainly four or five times, but the seed should be left in longer each successive time, as the solution is becoming constantly weaker.

The above recommendations are based upon fragmentary data, but it is believed that they are within safe limits, although undoubtedly they may need modification to adopt them to the best practice when more exact knowledge is obtainable.

In a test of fungicides upon oats conducted in 1898, an immersion of seed for ten minutes in formalin solution of the strength of one pound to fifty gallons of water gave perfect germination of seed in the laboratory trial, and only eight-tenths of one per cent. of smut in the crop, against over twelve per cent. in the crop from untreated seed. Two weaker solutions with the same length of immersion were tried with correspondingly poorer results. At that time the necessity for a long exposure to the action of the fungicide was not so fully recognized. Many laboratory experiments conducted by Mr. William Stuart, the assistant botanist, have since

been tried by exposing the spores to various treatments and testing their germination by direct cultures in hanging drops, which have greatly helped to an understanding of the subject.

Several trials with formalin on wheat are in progress, and the data in the accompanying table taken from the records now available have interest in this connection. They show that so far as the seed grain is concerned, a treatment of two hours in a solution of the strength of one pound of formalin to fifty gallons of water is slightly, if at all, injurious to the after growth, whether tested by laboratory

Formalin Treatment of Wheat in 1898–99.

Seed sown in the field after immersion in fungicide solution, in simple water, or untreated.

DATE	Treatment		Laboratory germination	Field germination	Appearance April 10, 1899
	Strength	Time			
Sept. 17 1898	.....	.....	95.5	Good	Good
	1 lb. formalin 50 gals. water	2 hrs.	95.5	Good	Good
	2 lbs formalin 50 gals. water	2 hrs.	89.5	Medium	Considerably injured
Sept. 26 1898	.....	.....	95.5	Good	Good
	1 lb. formalin 50 gals. water	2 hrs.	87.	Good	Good
Sept. 26 1898	Water at room temperature	½ hr.	98.	Good	Good
	2 lbs formalin 50 gals. water	½ hr.	81.	Poor	Slightly injured

or field observations. For further results the harvest must be awaited.

The work at the North Dakota station, already referred to (Bulletin No. 27), gives strong warrant for believing that success may be attained when the seed is sprinkled with the formalin solution, instead of using a bath. By this method the seed is spread out on a floor, sprinkled until thoroughly wet with a solution of the same strength as already recommended, shoveled over rapidly to distribute the moisture evenly, then piled up and covered, if con-

venient, with a canvass. At the end of two hours the seed is spread out and allowed to dry as rapidly as possible, when it can be sacked ready for sowing. If this method is used, it must be remembered that oats will require more of the solution than wheat, in order to fully wet between and within the hulls.

By either form of treatment, immersion or sprinkling, the grains will be considerably swollen, and larger measure of seed must be sown per acre, if the sowing is done soon after treatment, as will usually be the case. If seed is kept long after treatment, care must be taken that it does not heat, otherwise no harm or disadvantage will result. Professor Bolley, from some preliminary trials, estimates that when sown soon after treatment it will be necessary to set the drill for 3½ bushels of oats per acre, if the equivalent of 2½ bushels of dry seed is desired, and with wheat it must be set for one bushel and eighteen quarts per acre, if desired to sow one bushel and four quarts. This will be some guide, but the farmer must, to a considerable extent, make his own estimates.

Potatoes.

The use of formalin for prevention of potato scab was first suggested by this station in a newspaper bulletin issued February 26, 1897, and the full results of studies made in 1895-96, were presented in a bulletin (No. 65) issued in June, 1897. Some subsequent information was included in the annual report for 1897, distributed in April, 1898.

The remedy has been used by many individuals who have uniformly reported excellent, and usually entirely satisfactory results, and by a number of the experiment stations, also with approval. The treatment is easily applied and gives in all cases a far superior crop, and in soil free of germs is as complete a remedy as probably can be devised.

The method of treatment is to immerse the seed potatoes for two hours in a solution of the strength of one half pound of formalin to fifteen gallons of water. If the time is extended to three or four hours, there will be greater certainty of killing every germ of the disease, particularly in the deeply scabbed tubers, without materially endangering the growth of the potatoes. Potatoes not much sprouted have been left in a solution of the above strength for a number of days without the slightest injury. After treatment the tubers are

cut and planted in the usual manner, either at once or after a time.

The same solution may be used five or six times in succession, if the period for immersion is made a little longer each time to balance the gradual dilution of the solution, and particularly if the tubers are reasonably free from dirt.

The strength of the solution recommended for potatoes is based upon numerous trials, and may be considered about the best for use in all cases, but there is no need of attempting special accuracy, as the range for efficiency is quite wide. The solution for potatoes is twice as strong as can safely be employed for grain.

Summary.

The use of formalin for smut in wheat and oats and for scab in potatoes is found by many trials to be one of the cheapest, simplest and most efficient remedies yet suggested. As formalin is practically non-poisonous, non-corrosive, and easy to obtain and handle, there seems little doubt of its coming into common use as a fungicide.

The diseases covered by this bulletin, with their remedies, are as follows:

Corn smut: Gather and thoroughly destroy (burn) the smut balls during the growing season, and afterward. Treating the seed is of no use.

Wheat, loose smut: No efficient remedy for farm practice can yet be recommended.

Oat smut and Stinking smut of wheat: A simple and inexpensive treatment of the seed grain with formalin will entirely prevent the attack of these smuts.

Add ½ pound of formalin to 30 gallons of water and immerse the seed grain for 2 hours, then spread out and dry.

Or, sprinkle the grain with the formalin solution until thoroughly wet, shoveling over rapidly to distribute the moisture evenly, then place in a pile (covered with sacking) for 2 hours, and finally spread out and dry as in the other method.

Grain swollen in this manner requires the drill to be set somewhat wider to permit the usual amount of seed to be sown per acre.

Potato scab: The formalin treatment of seed potatoes practically frees the crop from scab, with slight expense and trouble.

Add ½ pound of formalin to 15 gallons of water and immerse the seed tubers for not less than 2 hours. If the potatoes are not much sprouted, a longer wetting is advantageous. After removing from the solution, cut and plant as usual.

In the use of formalin no special precautions are required.